CLAIMS

Having thus described the invention, what is claimed is:

1. A method for determining the length (b) of at least one of two legs (13, 14) of a workpiece (12), which have been bent toward each other by means of a bending die (6) at a bending angle (ß) whose vertex (S) is located at the point of intersection of the straight, angle forming projections (29, 30) of the legs (13, 14) of the bent part (12), with one end (E) of the leg (13, 14) to be measured limiting the latter on the far side opposite the bending angle vertex (S), comprising:

(a) holding the object part (12) in the bending die (6);

(b) determining the position of the bending angle vertex (S) and the position of the end (E) of the leg (13, 14); and

(c) from the respective position of the bending angle vertex (S) and of the end (E) thus determined, calculating the length (b) of the leg as the distance between the said bending angle vertex (S) and the said end (E).

2. The method for determining the length of at least one of two legs of a workpiece in accordance with Claim 1 wherein the workpiece (12) is retained in the bending die (6) in a defined position.

3. The method for determining the length of at least one of two legs of a workpiece in accordance with Claim 1 wherein the position of the bending angle vertex (S) is determined by initially determining the bending angle (ß).

4. The method for determining the length of at least one of two legs of a workpiece in accordance with Claim 1 wherein, during the step of determining the position of the bending angle vertex (S), the workpiece (12) is supported on a backing surface (27,28) and the position of the bending angle vertex (S) is determined on the basis of the position in which the workpiece (12) is supported on said backing surface (27, 28).

5. The method for determining the length of at least one of two legs of a workpiece in accordance with Claim 1 wherein the position of the bending angle vertex (S) is determined by measuring the bending angle (ß) by optical means.

6. The method for determining the length of at least one of two legs of a workpiece in accordance with Claim 1 wherein the position of the end of the leg (13,14) of the workpiece (12) is determined by optical means.

7. A method for bending workpieces wherein two angular legs (13, 14) of a workpiece are bent toward each other in a bending die (6) at a bending angle (ß) to produce a bent workpiece (12), the length (b) of at least one of the said legs (13, 14) is determined with a bending angle vertex (S) located at the point of intersection of the straight projections (29, 30) of the legs that form the angle (ß) of the legs (13, 14) of the workpiece (12) and with the end (E) of the leg (13, 14) delimiting the latter on the far side from the bending angle vertex (S).

8. The method for bending workpieces in accordance with Claim 7 wherein the actual value obtained as a result of the determination of the length (b) of a leg (13, 14) is compared to a leg length set point value and that the result of said actual value/set point value comparison is used to define at least one parameter of significance for the length (b) in a subsequent bending step.

9. Apparatus for determining the length (b) of at least one out of two legs (13, 14) of a workpiece (12) which have been bent toward each other by means of a bending die (6) at a bending angle (ß) whose bending angle vertex (S) is located at the point of intersection of the straight projections (29, 30) of the legs (13, 14) forming the angle (ß) of the legs (13, 14) of the workpiece (12) while an end (E) of the leg (13, 14) concerned delimits the latter on the far side from the bending angle vertex (S), said apparatus including:

(a) a system (31) for determining the position of the bending angle vertex (S);

(b) a unit (34) for determining the position of the end (E); and

(c) an evaluation unit (36), said system (31) and unit (34) permitting the determination of the position of the bending angle vertex (S) and the position of the end (E) of a bent workpiece (12) held in the bending die (6) in a defined position, and said evaluation unit (36) processing data on the position of the bending angle vertex (S) and of the end (E) to determine the length (b) as the distance between the bending angle vertex (S) and the end (E).

10. The apparatus for determining the length of at least one of two legs (13, 14) of a workpiece in accordance with Claim 9 wherein a retaining element is provided for the determination of the position of the bending angle vertex (S) and the determination of the position of the end (E), with the workpiece (12) being is held in specifically defined fashion in the bending die (6).

11. The apparatus for determining the length of at least one of two legs (13, 14) of a workpiece in accordance with Claim 9 wherein the system (31) for determining the position of the bending angle vertex (S) includes a unit (9) serving to measure the bending angle (ß) as well as a processor that connects to the unit (9) measuring the bending angle (ß) and to the evaluation unit (36), said processor (32) determining the position of the bending angle vertex (S) on the basis of the bending angle (ß) thus measured.

12. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 9 wherein the system (31) for determining the position of the bending angle vertex (S) includes a processor (32) connected to the evaluation unit (36), and a backing surface (27, 28) supporting the workpiece (12) for the determination of the position of the bending angle vertex (S), said processor (32) determining the position of the bending angle vertex (S) on the basis of the position of the support for the workpiece (12) on the backing surface (27, 28).

13. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 9 wherein the unit measuring the bending angle (ß) is an optical measuring tool.

14. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 9 wherein the unit (34) serving to determine the position of the end (E) includes a detection and acquisition unit (20, 21) for capturing the position of the end (E), and a processor (35) connected to the detection and acquisition unit (20,21) and also to the evaluation unit (36), said processor (35) determining the position of the end (E) on the basis of the position of the end (E) captured by the detection and acquisition unit (20, 21).

15. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 14 wherein the detection and acquisition unit serving to capture the position of the end (E) may include a tactile contact sensor assembly that can be brought into contact with the end (E).

16. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 15 wherein the contact sensor assembly that is in contact with the end (E) is capable of moving with the end (E) during the bending process.

17. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 15 wherein the contact sensor assembly comprises a positioning stop lug (17, 18) for the workpiece to be bent.

18. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 14 wherein the detection and acquisition unit (20, 21) serving to capture the position of the end (E) is an optical image acquisition unit (20, 21).

19. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 9 mounted in a device for bending workpieces including a bending die (6) by means of which at least two legs (13, 14) of a workpiece can be bent toward each other to produce a bent workpiece (12) with a bending angle (ß) whose bending angle vertex (S) is located at the point of intersection of the projections (29, 30) forming the angle (ß) of the legs (13, 14) of the bent workpiece (12), and an end (E) of the respective leg (13, 14) delimiting the latter on the far side opposite the bending angle vertex (S), and, additionally, a system for determining the length (b) of a leg (13,14).

20. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 19 wherein the bending die (6) itself serves as the retaining element for the defined placement of the workpiece (12) for the determination of the bending angle vertex (S) and/or for the determination of the position of the end (E).

21. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 20 wherein a backing surface (27, 28) supporting the workpiece (12) for the determination of the position of the bending angle vertex (S) is provided by the bending die (6).

22. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 21 wherein a contact sensor assembly in the detection and acquisition unit (34) serving to capture the position of the end (E) is constituted of a positioning stop (17, 18) of the bending device against which the workpiece can be set for appropriate positioning relative to the bending die (6) prior to being processed.

23. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 22 an optical detection and acquisition unit (20, 21) for capturing the position of the end (E) is at least in part mounted on a positioning stop (17, 18) of the bending device.

24. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 23 wherein the positioning stop (17, 18) is preferably movable by the control system (11).

25. The apparatus for determining the length of at least one of two legs (13,14) of a workpiece in accordance with Claim 24 wherein, for determining the length (b) of a leg, there is included an evaluation unit (36) as a part of a system controller (11) in which at least one set point value for the length (b) is stored and by means of which an actual length value can be compared against a length set point value, and, on the basis of the result of the actual versus set point length comparison, at least one parameter controlling the length (b) in at least one subsequent bending operation can be defined.